Guidance Manual

How to Implement the Department of Ecology's Rule on Power Plant Carbon Dioxide (CO_2) Emissions Mitigation (Chapter 173-407 WAC)

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Background information and purpose

Based on legislation, the Department of Ecology (Ecology) was required to write rules for power plants that are not subject to Energy Facility Site Evaluation Council (EFSEC) regulations. In general, these are power plants that are smaller than 350 megawatts.

The purpose of this document is to help you implement Ecology's regulations by determining:

- Whether the program requirements apply to a facility,
- How much mitigation is required, and
- Options available to accomplish mitigation.

Section 1
Which electric generators are subject to the carbon dioxide (CO_2) mitigation program?

The program applies to new electric generating facilities and modifications to existing electric generating facilities.

New electric generating facilities

- Any new facility for which a Notice of Construction (NOC) application is submitted on or after July 1, 2004
- Any new facility with:
    - A station generating capacity of at least 25 megawatts of electricity (MWe)
    - At least one generating unit
    - Fossil fuel as all or part of its fuel
    - Some or all of its electricity for sale

Modifications to existing electric generating facilities

- Any existing facility modified on or after July 1, 2004
- Any existing facility with:
    - Generating capacity of at least 25 MWe
    - At least one generating unit
    - Fossil fuel as all or part of its fuel
    - Some or all of its electricity for sale
    - Changes resulting in an increase of at least:
        - 25 MWe, or
        - 15% in annual CO_2 emissions from fossil fuels

Note:

- Not all changes under the CO_2 mitigation program are subject to permitting under WAC 173-400-110.
- Existing generating stations with site certification agreements with EFSEC are subject to EFSEC rules.
- An existing generator may be part of a facility that does not produce electricity as its primary product for sale.

Examples of changes that could increase CO_2 emissions or station generating capacity are:

- New electrical generating equipment
- Physical changes to existing generating units that increase their electrical output. This might result from changes to:
    - steam turbine efficiency
    - a combustion turbine
    - the facility to support a new steam turbine
- Changes in types of fossil fuels used
- Increased annual use of a fossil fuel
- Addition of fossil fuel to a biomass fired electrical generating station
- Addition of new generating units at an existing electric generating station
- A change in the permit to allow the facility to use more fossil fuels or use them at a higher rate. This may include:
    - Addition of a fossil fuel to a biomass fired station
    - A change from natural gas to oil or coal
    - A change from oil to coal
    - Increase in permitted annual hours of operation
    - Increase in permitted annual fuel combusted
    - Increase in permitted annual electrical output
    - Increase in electrical output due to reductions in cogeneration

What is a fossil fuel?

- petroleum-based fuels
- LPG/LNG
- reprocessed lubricating oils
- natural gas
- propane
- petroleum coke
- coal
- "syn gas" from coal
- coal bed methane
- coal (town) gas

For purposes of this program, fossil fuel is not:

- wood waste or hog fuel
- plastics
- petroleum-contaminated soils
- biomass
- roofing tear-off
- tires or tennis shoes
- biologically derived fuels including:
    - methane from landfills
    - wastewater sludge anaerobic digesters
    - animal waste anaerobic digesters
    - methanol or ethanol from biological fermentation of biomass or coal

Section 2
How do I calculate the amount of CO_2 emissions for mitigation?

You need to calculate the following:

1. Annual CO_2 emissions.
2. The amount of CO_2 emissions subject to mitigation program requirements.

Calculate annual CO_2 emissions using the following equation:
(See Section 6 of this document for example calculations)

$$CO_{2rate} = \frac{F_s \times K_s}{2204.6} \times T_s + \frac{F_1 \times K_1}{2204.6} \times T_1 + \frac{F_2 \times K_2}{2204.6} \times T_2 + \frac{F_3 \times K_3}{2204.6} \times T_3 \ldots + \frac{F_n \times K_n}{2204.6} \times T_n$$

Note: The result of this and all following calculations are in metric tons per year

Where:
CO_2 rate = Maximum potential emissions in metric tons per year
F_{1-n} = Maximum design fuel firing rate in mmBTU/hour based on equipment in new condition
K_{1-n} = Conversion factor for the fuel(s) being evaluated in lb CO_2/mmBtu for fuel F_n. The factors are given in Section 1 above and in WAC 173-407-050(1)(e)
T_{1-n} = Hours per year fuel F_n is allowed to be used. The default is 8760 hours unless there is a limitation on hours in an order of approval.
F_s = The design fuel firing rate in mmBtu/hr of any supplemental fuel firing allowed in the permit.
K_s = Conversion factor for the supplemental fuel, in lb CO_2/mmBtu
T_s = Annual hours per year that supplemental fuel firing is allowed. The default is 8760 hours unless there is a limitation on hours in an order of approval.

Assumptions:

1. The facility will use as its primary fuel the highest CO_2 producing fuel allowed under the terms of the permit.
2. The facility will then use lower emitting fuels as necessary to fill up the annual hours allowed in the order of approval.

Calculate CO_2 emissions subject to mitigation using the following equations:

1. First, calculate 30-year emissions: This calculation determines the maximum CO_2 emissions that are potentially subject to mitigation.

   Total CO_2 Emissions = CO_2 rate X 30 X 0.6 X 0.2

   Where:
   30 is the number of years of operation to be mitigated under the law
   0.6 is the capacity utilization of the generating facility in RCW 80.70.020(17)
   0.2 is the mitigation rate factor in RCW 80.70.020(4)

2. Next, calculate the cogeneration credit: If the facility is installing a qualifying cogeneration project, it may be eligible for a cogeneration credit. Use the following equation:

$$CO_{2credit} = \frac{H_s}{2204.6}\left(K_z\right) \div 0.35$$

   Where:
   CO_2 credit = The annual CO_2 credit for cogeneration in metric tons/year
   H_s = Annual heat energy supplied by the cogeneration plant to the "steam host" per the contract or other binding obligation or agreement between the parties in mmBtu/yr.
   K_a = The time weighted average CO_2 emission rate constant for the cogeneration plant in lb CO_2/mmBtu supplied. The time weighted average is calculated similarly to the above method.
   E = The assumed net energy conversion efficiency of a boiler

3. Last, calculate emissions subject to mitigation: The quantity of CO_2 to be mitigated is the difference between the total CO_2 emissions and the cogeneration credit.

   CO_2 to Mitigate = Total CO_2 Emissions - CO_2 credit

   If the CO_2 to be mitigated is zero or less, none of the CO_2 emissions from the facility need mitigation. Negative mitigation quantities cannot be used for future offsets.

Section 3
What options are available to accomplish mitigation?

The applicant can choose one or any combination of the following three mitigation options:

1. Pay a specified amount to an organization on the list of Independent Qualified Organizations (IQOs) developed and maintained by EFSEC
2. Purchase CO_2 credits from an EFSEC-recognized trading organization
3. Design and implement your own mitigation plan

No matter which option(s) it chooses, each applicant needs to prepare and submit a mitigation plan.

Mitigation plans

- Submitting the plan: Each applicant must submit a mitigation plan to its permitting authority as part of a Notice of Construction/PSD application. This plan shows how the owner or operator will meet the CO2 mitigation requirements. The applicant should identify in this plan which of the above three mitigation option(s) they will use. If an applicant does not have a clear project schedule and cannot commit to specific actions, it may submit a more general plan.

- Plan approval: Before the applicant can take any mitigation action, the permitting authority must approve the plan as part of the Order of Approval or PSD permit.

- Modifying the plan: The applicant can modify a mitigation plan after the plan has been approved; however, an applicant cannot modify a plan once it has already done the mitigation.

Option 1: Pay an Independent Qualified Organization

The applicant proposes to meet its CO_2 mitigation requirement by paying an Independent Qualified Organization. The applicant can do this in one of two ways:

1. A lump sum payment; or
2. Five equal, annual payments.

When is payment due?

The lump sum payment or first of five payments is due 120 days after:

- a new facility starts operating commercially, or
- a modified facility returns to normal operation after the modification.

What should the mitigation plan for Option 1 include?

- The name of the IQO or the date the applicant will choose an IQO and provide its name to the permitting authority,
- The date the applicant will inform the permitting authority that they have signed a contract with the IQO, and
- A commitment to send the payment to the IQO.

How much is the mitigation payment?

Multiply the calculated CO_2 to be mitigated times the dollars per ton mitigation rate. As of July 1, 2004, the dollars per ton mitigation rate is $1.60 per metric ton to be mitigated.

Note: The mitigation rate can only be changed through rulemaking by EFSEC or legislative action. If changed through rulemaking, the mitigation rate cannot increase by more than 50% at one time.

Option 2: Purchase CO_2 credits from an EFSEC-recognized trading organization

The credits purchased must meet the following conditions:

- Registered with a state, national or international trading authority or exchange recognized by EFSEC
- Equal in quantity to the CO_2 mitigation quantity (in metric tons)

What should the mitigation plan for Option 2 include?

- The name of the EFSEC-recognized trading organization, and
- The date the applicant will acquire the credits.

OR

- The date by which the applicant will inform the permitting authority which trading organization it will use,
- The amount of credits the applicant will purchase, and
- The date by which the applicant will provide documentation to the permitting authority that it purchased the credits.

Note: The applicant shall not sell or trade credits without prior approval from the permitting authority.

Option 3: Design and implement your own mitigation plan

The permitting authority must approve the mitigation plan.

The mitigation plan for this option can include pieces of the other two options. For example, an applicant using this option may choose to pay an IQO for part of its mitigation requirement, and implement a mitigation project for the rest.

What are the requirements for Option 3 mitigation plans?

- The total dollar value of the plan is limited to what would be paid to an Independent Qualified Organization in Option 1.
- Projects must meet the criteria for acceptable projects described in Ecology's rule
- The applicant either directly conducts mitigation projects, or directs a third party on how to conduct the projects.
- The mitigation plan must give a date by which the project(s) will be implemented (this must be as soon as possible after the facility begins operating).

What kinds of projects are acceptable?

You can find guidance on acceptable projects from organizations that develop and approve mitigation projects, such as:

- Oregon Climate Trust
- Seattle City Light
- World Bank
- Pew Center on Global Climate Change
- Northeast States for Coordinated Air Use Management (NESCAUM) (http://www.nescaum.org/Greenhouse/index.html)
- World Business Council for Sustainable Development
- (http://www.ghgprotocol.org/)
- California Climate Action Registry (http://198.104.131.213/PROTOCOLS/)
- Other organizations yet to be identified

Examples of mitigation projects for Option 3 include:

- Energy efficiency measures
- Clean and efficient transportation measures
- Managing electricity consumption
- Sequestering carbon dioxide
- Cogeneration
- Reductions in CO_2 or CO_2 equivalents approved in the carbon dioxide mitigation plan
- Carbon credits traded or handled by a trading authority or exchange not recognized by EFSEC

What should the mitigation plan for Option 3 include?

- A detailed description of all proposed mitigation projects
- An explanation of how each project reduces CO2 or greenhouse gas emissions
- The estimated amount of CO2 that each project will reduce
- An evaluation of how well the proposed project will meet its goal
- A demonstration that the CO2 reductions from each project are “permanent”
- Information about potential “leakage” caused by implementing each proposed project
- A schedule for implementing the proposed mitigation projects

Section 4
How do you submit a CO_2 mitigation plan?

You will need to send your CO_2 mitigation plan with your Notice of Construction to a permitting authority. The permitting authority is determined by:

- Location of the project
- Size of the generating station or modification
- The authority that permits the existing electric generating station, if there is one

New projects

For projects 350 megawatts or more:

- Send project applications to the Washington Energy Facility Site Evaluation Council (EFSEC). You can contact EFSEC at:

  Energy Facility Site Evaluation Council
  925 Plum Street SE, Building 4
  P.O. Box 43172
  Olympia, WA 98504-3172
  Phone: 360-956-2121
  Fax: 360-956-2158

  For siting of new projects, contact:
  Irina Makarow, Siting Manager
  Irinam@cted.wa.gov
  (360) 956-2047

For projects less than 350 megawatts:

- Send project applications to the local air quality agency with jurisdiction over the county in which the project is located. See Appendix 1 for a map of the jurisdictions and how to contact the agencies.

Modifications to existing generating facilities

For all modifications to generating stations already permitted by EFSEC:

- Send project applications to EFSEC. (See above for contact information)

For modifications 350 megawatts or more:

- Send project applications to EFSEC. (See above for contact information)

For modifications less than 350 megawatts:

- Send project applications to the local air quality agency with jurisdiction over the county in which the project is located. See Appendix 1 for a map of the jurisdictions and how to contact the agencies.

Section 5
What is the role of the reviewing authority?

Reviewing authorities:

1. Review NOC applications and CO_2 mitigation plans. For information about this process, see the Ecology document "How to Apply for a Notice of Construction" at http://www.ecy.wa.gov/pubs/ecy070121.pdf .
2. Conduct annual reviews to assure compliance with the mitigation plan. For information about this process, see Appendix 3.
3. Set annual fees for compliance reviews. For information about this process, see Appendix 3.

Section 6
Example calculations

Here are eight examples of how to calculate CO_2 emissions and mitigation quantities. The examples include a demonstration of the calculation and information about applicability. All examples assume some or all of the electricity produced will be sold, unless noted otherwise.

Example 1: New facilities

Combustion turbine added to an existing (pre-2003) generating facility:

- Turbine, simple cycle, 42 MWe, net (348.2 MMBtu/hr heat input)
- Permitted at 8760 hours/year natural gas or #2 oil
  - Natural Gas K factor = 117.6
  - #2 Oil K factor = 158.16
- No cogeneration credit

- Calculate the annual CO_2 emissions in metric tons/year:

$$\text{metric ton } CO_2 \text{/year} = \frac{\text{Heat input rate} \times \text{K factor for \#2 oil} \times \text{permitted operating hours per year on oil}}{\text{lb to metric ton conversion factor}} + \frac{\text{Heat input rate} \times \text{K factor for gas} \times (\text{8760 hr/yr} - \text{permitted operating hours per year on oil})}{\text{lb to metric ton conversion factor}}$$

$$218{,}826 = \frac{348.2 \times 158.16 \times 8760}{2204.6} + \frac{348.2 \times 117.6 \times (8760 - 8760)}{2204.6}$$

- Calculate the quantity of CO_2 to mitigate:

$$\text{metric tons } CO_2 = \text{annual metric tons} \times 30 \text{ years} \times 60\% \text{ capacity factor} \times 20\% - \text{cogeneration credit}$$

$$787{,}775 \text{ metric tons } CO_2 = 218{,}826 \times 30 \times 0.6 \times 0.2 - 0 \times 30$$

- Calculate Mitigation Option 1 value:

  Mitigation cost = metric tons CO_2 X $/metric ton CO_2

  $1,260,440 = 787,775 tons X $1.60/ton

Example 1A: New facilities permitted for part-time operation

This example has all the same characteristics as Example 1, except the applicant requests limiting operation to 3,500 hours per year.

- Calculate the annual CO_2 emissions in metric tons/year:

$$\text{metric ton } CO_2 \text{ /year} = \frac{\text{Heat input rate} \times \text{K factor for \#2 oil} \times \text{permitted operating hours per year on oil}}{\text{lb to metric ton conversion factor}} + \frac{\text{Heat input rate} \times \text{K factor for gas} \times (\text{3500 hr/yr} - \text{permitted operating hours per year on oil})}{\text{lb to metric ton conversion factor}}$$

$$87{,}430 = \frac{348.2 \times 158.16 \times 3500}{2204.6} + \frac{348.2 \times 117.6 \times (3500 - 3500)}{2204.6}$$

- Calculate the quantity of CO_2 to mitigate:

$$\text{metric tons } CO_2 = \text{annual metric tons} \times 30 \text{ years} \times 60\% \text{ capacity factor} \times 20\% - \text{cogeneration credit}$$

$$314{,}750 \text{ metric tons} = 87{,}430 \times 30 \times 0.6 \times 0.2 - 0 \times 30$$

- Calculate Mitigation Option 1 value:

  Mitigation cost = metric tons CO_2 X $/metric ton CO_2

  $503,600 = 314,750 tons X $1.60/ton

Example 2: New generating unit capable of operating on a variety of different fuels

Solid fuel boiler with multiple fuels:

- 100 MWe, 975 mmBtu/hr
- Annual fuel allowed:
  - 100 % natural gas (8760 – 4380 – 2628 = 1752 hrs/yr)
  - 50% high volatile, sub-bituminous coal (50% X 8760 = 4380 hrs/yr)
  - 30% petroleum coke (30% X 8760 = 2628 hrs/yr)
  - 20% tire derived fuel (TDF) (0 hrs/yr)
- K factors:
  - Natural gas = 117.6 lb/mmBtu
  - High volatile subbituminous coal 306.11 lb/mmBtu
  - Petroleum coke = 242.91 lb/mmBtu
  - TDF = 0.00 lb/mmBtu (TDF is not a fossil fuel)
- No cogeneration

- Calculate the annual CO_2 emissions in metric tons/year

$$\text{metric ton } CO_2 \text{/year} = \frac{\text{Heat input rate} \times \text{K factor for coal} \times \text{permitted operating hours per year on coal}}{\text{lb to metric ton conversion factor}} +$$

$$\frac{\text{Heat input rate} \times \text{K factor for coke} \times (\text{8760 hr/yr} - \text{permitted operating hours per year on coal})}{\text{lb to metric ton conversion factor}}$$

$$\frac{\text{Heat input rate} \times \text{K factor for gas} \times (\text{8760 hr/yr} - \text{permitted operating hours per year on coal and coke})}{\text{lb to metric ton conversion factor}}$$

$$\frac{\text{Heat input rate} \times \text{K factor for TDF} \times (\text{8760 hr/yr} - \text{permitted operating hours per year on coal coke and natural gas})}{\text{lb to metric ton conversion factor}}$$

$$966{,}405 = \frac{975 \times 306.11 \times 4380}{2204.6} + \frac{975 \times 242.91 \times 2628}{2204.6} + \frac{975 \times 117.6 \times 1752}{2204.6} + \frac{975 \times 0.00 \times 0}{2204.6}$$

- Calculate the quantity of CO_2 to mitigate

metric tons CO_2 = annual metric tons X 30 years X 60% capacity factor X 20% - cogeneration credit

3,479,056 metric tons = 966,405 X 30 X 0.6 X 0.2 – 0 X 30

- Calculate Mitigation Option 1 value

Mitigation cost = metric tons CO_2 X $/metric ton CO_2

$5,566,490 = 3,479,056 tons X $1.60/ton

Example 3: New generating unit primarily using wood fuel but with oil back-up fuel

Wood fired boiler system:

- 50 MWe, all for sale
- Boiler heat input of 488 mmBtu/hr
- Annual fuel allowed:
  - 100% wood waste primary fuel
  - 300,000 gallons/year of #4 oil as starting and back-up fuel
- Conversion factors:
  - Heat content of #4 oil = 145,000 Btu/gallon
  - K factor for #4 oil = 160.96 lb CO_2/mmBtu
  - K factor for wood waste = 0.00 lb CO_2/mmBtu
- No cogeneration

The annual CO_2 emissions in metric tons/year from wood waste is Zero (0) because wood is not a fossil fuel. You only need to calculate the emissions from the fossil fuel.

This example uses an alternate method to calculate CO_2 emissions. This method converts the total quantity of oil allowed for use each year, and determines the annual Btu the oil provides to the boiler. You then use the annual Btu from oil combustion to calculate annual CO_2 emissions. The quantity of CO_2 emitted using this method is the same as the quantity emitted using the standard method.

- Calculate the annual CO_2 emissions in metric tons/year from oil

  Since the quantity of oil is given, we can determine the annual Btu supplied by that quantity of oil for calculating the annual CO_2 emissions

$$\text{43,500 mmBtu from oil/yr} = \frac{\text{300,000 gal \#4 oil/yr} \times \text{145,000 Btu/gal \#4 oil}}{\text{1,000,000}}$$

$$\text{3176 metric ton } CO_2\text{/year} = \frac{\text{43500 mmBtu from oil/yr} \times \text{160.96 lb } CO_2\text{/mmBtu}}{\text{2204.6 lb/metric ton}}$$

- Calculate the quantity of CO_2 to mitigate:

metric tons CO_2 = annual metric tons X 30 years X 60% capacity factor X 20% - cogeneration credit

11,434 metric tons CO_2 = 3,176 X 30 X 0.6 X 0.2 – 0 X 30

- Calculate Mitigation Option 1 value

Mitigation cost = metric tons CO_2 X $/metric ton CO_2

$18,294 = 11,434 tons X $1.60/ton

Example 4: Modifying an existing generating unit to increase output

Existing simple cycle turbine upgraded with duct firing to combined cycle:

- Large frame-type turbine
- Natural gas only
- HRSG plus Steam turbine adds 100+ MWe
- Duct Burner rate of 500 mmBtu/hr
- Natural gas only
- No restriction on operation of duct burner

This is an existing unit with existing emissions. The addition of the duct burner is the modification that both increases electrical output and increases CO_2 emissions. As an existing electrical generating unit/station, the date the turbine is originally installed does not matter in this example. The example focuses only on the effects of the modification.

- Calculate the annual CO_2 emissions in metric tons/year

$$\text{metric ton } CO_2 \text{ /year} = \frac{\text{Heat input rate} \times \text{K factor for gasl} \times \text{permitted operating hours per year on gas}}{\text{lb to metric ton conversion factor}}$$

$$233{,}642 \text{ metric ton } CO_2 \text{ /yr} = \frac{500 \text{ MMBtu/hr} \times 117.6 \text{ lb } CO_2\text{/MMBtu} \times 8760 \text{ hr/yr}}{2204.6 \text{ lb/metric ton}}$$

- Calculate the quantity of CO_2 to mitigate

$$\text{metric tons } CO_2 = \text{annual metric tons} \times 30 \text{ years} \times 60\% \text{ capacity factor} \times 20\% - \text{cogeneration credit}$$

$$841{,}112 \text{ metric tons} = 233{,}642 \times 30 \times 0.6 \times 0.2 - 0 \times 30$$

- Calculate Mitigation Option 1 value

Mitigation cost = metric tons CO_2 X $/metric ton CO_2

$1,260,440 = 787,775 tons X $1.60/ton

Example 4A: Modifying an existing generating unit to increase output, including cogeneration

While upgrading the generating capacity of the turbine in Example 4, the owner also contracts to continuously supply 150 mmBtu/hr of steam energy for a use other than simply making electricity. The other use may be: supplying heating or process heat to an adjoining industrial, commercial or high density residential facility; or redesigning/modifying operation of another part of its own industrial plant to make use of this steam supply.

> Note: This example assumes natural gas is available and the fuel of choice to use. In a location where natural gas is not available, the use of an appropriate alternate fuel (such as #2 oil) is encouraged.

- Calculate the annual CO_2 emissions for the cogeneration credit in metric tons/yr. This quantity is based on the CO_2 resulting from generating the 150 MMBtu/hr of steam energy being supplied.

$$\text{metric ton } CO_2 \text{ /year} = \frac{\text{Heat input rate} \times \text{K factor for gas} \times \text{permitted operating hours per year on gas}}{\text{lb to metric ton conversion factor} \times \text{Boiler efficiency}}$$

$$200{,}266 \text{ metric ton } CO_2\text{/yr} = \frac{150\text{MMBtu/hr} \times 117.6 \text{ lb } CO_2\text{/MMBtu/hr} \times 8760 \text{ hr/yr}}{2204.6 \text{ lb/metric ton} \times 0.35 \text{ Btu out/Btu in}}$$

- Calculate the quantity of CO_2 to mitigate

  The basic formula is:

  CO_2 rate X 30 X 0.6 X 0.2 – CO_2 credit X 30

  Mitigation Quantity = CO_2 increase due to duct burner project - CO_2 emissions not generated due to cogeneration

  - 5,167,000 metric tons CO_2 = 841,111 metric ton CO_2 – 200,266 metric ton CO_2 /yr X 30 years

Because this project uses cogeneration, it does not need further CO_2 mitigation. The applicant has complied with the regulation. The regulator needs to make the cogeneration an enforceable provision of the Order(s) of Approval.

Example 5: Modifying an existing generating unit by adding a new steam turbine

Fossil fueled boiler system:

- 100% fossil fuel fired (natural gas and oil)
- 20 MWe generated for internal consumption
- Boiler operated at about 60% capacity
- Remainder of boiler output sent to area heating/cooling system

Proposal:

- Add 20 MWe for external sale
- No modifications to existing boilers required

Is this modification subject to the CO_2 mitigation program?

No, for the following reasons:

- Facility did not sell electricity before adding new generator
- Existing generator size less than 25 MWe, net
- Proposed increase less than 25 MWe
- CO_2 increase may be greater than 15%, but existing generator size increase not large enough to subject it to mitigation program

The next modification could be subject to the mitigation rule, depending on whether it meets the modification criteria.

Example 6: Modifying a generating station by adding a new generating unit

The existing generating station is identical to the station described in Example 2. The generating station is modified by the installation of a new boiler providing steam to a 50 MWe generator.

- New boiler sized at 488 mmBtu/hr
- New boiler uses the same fuels under the same limitations as the original boiler system:
  - 100 % natural gas (8760 – 4380 – 2628 = 1752 hrs/yr)
  - 50% high volatile, sub-bituminous coal (50% X 8760 = 4380 hrs/yr)
  - 30% petroleum coke (30% X 8760 = 2628 hrs/yr)
  - 20% tire derived fuel (TDF) (0 hrs/yr)
- K factors:
  - Natural gas = 117.6 lb/mmBtu
  - High volatile subbituminous coal 306.11 lb/mmBtu
  - Petroleum coke = 242.91 lb/mmBtu
  - TDF = 0.00 lb/mmBtu (TDF is not a fossil fuel)
- No cogeneration

CO_2 mitigation does not apply to potential emissions from the existing boiler system, as they are unchanged. Mitigation is only required for emissions from the new boiler, since there is more than a 25MWe increase in the station generating capacity.

- Calculate the annual CO_2 emissions from the modification in metric tons/year

$$\text{metric ton } CO_2 \text{/year} = \frac{\text{Heat input rate} \times \text{K factor for coal} \times \text{permitted operating hours per year on coal}}{\text{lb to metric ton conversion factor}} +$$

$$\frac{\text{Heat input rate} \times \text{K factor for coke} \times (\text{8760 hr/yr} - \text{permitted operating hours per year on coal})}{\text{lb to metric ton conversion factor}}$$

$$\frac{\text{Heat input rate} \times \text{K factor for gas} \times (\text{8760 hr/yr} - \text{permitted operating hours per year on coal and coke})}{\text{lb to metric ton conversion factor}}$$

$$\frac{\text{Heat input rate} \times \text{K factor for TDF} \times (\text{8760 hr/yr} - \text{permitted operating hours per year on coal coke and natural gas})}{\text{lb to metric ton conversion factor}}$$

$$483{,}698 = \frac{488 \times 306.11 \times 4380}{2204.6} + \frac{488 \times 242.91 \times 2628}{2204.6} + \frac{488 \times 117.6 \times 1752}{2204.6} + \frac{488 \times 0.00 \times 0}{2204.6}$$

- Calculate the quantity of CO_2 to mitigate

metric tons CO_2 = annual metric tons X 30 years X 60% capacity factor X 20% - cogeneration credit

1,741,312 metric tons = 483,698 X 30 X 0.6 X 0.2 – 0 X 30

- Calculate Mitigation Option 1 value

Mitigation cost = metric tons CO_2 X $/metric ton CO_2

$2,786,099 = 1,741,312 tons X $1.60/ton

Example 7: Modifying a generating station in existence prior to CO_2 mitigation rule

The existing generating station is identical to the situation in Example 3 (50 MWe for sale, wood fueled with oil back-up). It is requesting to increase the annual quantity of oil it can use from 300,000 to 1,000,000 gallons.

Assume the existing generating station applied for and received a permit in 1990.
The increase in allowed fuel use is subject to the mitigation program because: (1) it results in a CO_2 increase of more than 15% from the previously permitted annual rate; and (2) the generating station produces more than 25 MWe for sale.

- Annual CO_2 from 300,000 gal oil = 3,176 metric ton CO_2/yr
- Annual CO_2 from 1,000,000 gal oil = 10,586 metric ton CO_2/yr
- Increase is 233% of the previous CO_2 emission rate
- Station generating capacity is unchanged

Note: A modification means changes that result in an increase of either of the following:
- 25 MWe, OR
- 15% in annual CO_2 emissions from fossil fuels.

Both do not have to occur for a modification to take place.

- Calculate the annual CO_2 from 300,000 gal/year of #4 oil

  See Example 3 for calculation

- Calculate the annual CO_2 from 1,000,000 gal/year of #4 oil

  Since the quantity of oil is given, we can determine the annual Btu supplied by that quantity of oil for calculating the annual CO_2 emissions

$$\text{145,000 mmBtu from oil/yr} = \frac{\text{1,000,000 gal \#4 oil/yr X 145,000 Btu/gal \#4 oil}}{\text{1,000,000}}$$

$$\text{10,586 metric ton } CO_2\text{/year} = \frac{\text{145000 mmBtu from oil/yr X 160.96 lb } CO_2\text{/mmBtu}}{\text{2204.6 lb/metric ton}}$$

- Calculate the quantity of CO_2 to mitigate

  First, what is the annual difference in CO_2 emissions due to the increase in #4 oil usage?

annual metric tons CO_2 increased = annual tons from 1,000,000 gal/yr - annual tons from 300,000 gal/yr

7,410 metric tons CO_2 per year increase = 10586 - 3176

What is the quantity of CO_2 to be mitigated due to the increased usage of #4 oil?

metric tons CO_2 = annual metric tons increased X 30 years X 60% capacity factor X 20% - cogeneration credit

26,676 metric tons CO_2 = 7,410 X 30 X 0.6 X 0.2 – 0 X 30

- Calculate Mitigation Option 1 value

  Mitigation cost = metric tons CO_2 X $/metric ton CO_2

  $42,681 = 26,676 tons X $1.60/ton

Example 7A: Modifying a generating station subject to the CO_2 mitigation program during original permitting

Assume the unit described in Example 7 applied for its NSR approval in 2005. The Notice of Construction approval restricted the annual fuel quantity to 300,000 gallons per year. The applicant requests an increase to 1,000,000 gallons per year. The increased CO_2 due to relaxing the operating restriction would be subject to mitigation.

Why would this be the case?

- The approving agency restricted use of #4 as part of its initial determination of required mitigation for the facility.
- Relaxing the restriction on fuel use changes the original basis for the mitigation quantity.
- Since this is the same emissions change scenario as Example 7, the annual CO_2 emissions increase by 15% or more.
- The increased quantity of CO_2 subject to mitigation is 26,676 metric tons.
- The Option 1 additional cost for mitigation is $42,681.

Example 8: A new 25 MWe fuel cell based generating unit

A 25 MWe fuel cell system which produces hydrogen in a dedicated, catalyst-based steam reformer which uses natural gas as its feedstock:

- The fuel cell system can operate 90% of the time, but the applicant is not requesting to limit the operation to this capacity.
- No existing hydrogen supply for the fuel cell system.
- Based on information from the manufacturer of the reformer, the reformer will produce 19.2 metric tons CO_2/hour.

- Calculate annual CO_2 emissions

metric ton CO_2/yr = hourly CO_2 emission rate X operating hours per year

168,192 metric ton CO_2/yr = 19.2 metric ton CO_2/hr X 8760 hr/yr

- Calculate the quantity of CO_2 to mitigate

metric tons CO_2 = annual metric tons X 30 years X 60% capacity factor X 20% - cogeneration credit

605,491 metric tons = 168,192 ton/yr X 30 yr X .6 X .2 - 0 X 30

- Calculate Mitigation Option 1 value

  Mitigation cost = metric tons CO_2 X $/metric ton CO_2

  $968,786 = 605,491 tons X $1.60/ton

Example 8A: A 25 MWe fuel cell based generating unit installed at a facility with an existing hydrogen plant

A 30 MWe fuel cell system is added to a chemical plant and uses hydrogen produced by an existing hydrogen plant (steam reformer).

- 100% of electrical output from the fuel cell system is sold
- The hydrogen plant uses natural gas for its feedstock.
- The fuel cell system is added to make use of excess hydrogen production capacity. No increases in hydrogen capacity required.

Is this unit subject to the CO_2 Mitigation program?

No, because the ability to produce hydrogen already exists for other purposes. It was not constructed or modified to supply hydrogen to the fuel cell system.

However, the unit could require mitigation if the applicant modified the hydrogen plant to:

- increase its capacity or
- construct another hydrogen plant to supply hydrogen to the fuel cell system.

Section 7
Definitions

Carbon dioxide equivalents (or equivalent): A measure in metric units used to compare the emissions from various greenhouse gases based on their global warming potential. You can find carbon dioxide equivalents for gases that contribute to global warming potential in sources such as the United Nations, US Dept. of Energy, and Environmental Protection Agency climate change program information. See RCW 80.70.010(4) (WAC 173-407-020(4))

Cogeneration plant or cogeneration: A fossil-fueled thermal power plant in which the heat or steam produced is also used for industrial or commercial heating or cooling purposes. A cogeneration plant also must meet federal energy regulatory commission standards for qualifying facilities under the public utility regulatory policies act of 1978. See RCW 80.70.010(6) (WAC 173-407-020(6))

Electric generating unit or generating unit: The smallest component of an electric generating station or power plant directly involved in making electricity. Examples are a steam boiler whose steam is used in whole or part to turn a steam turbine/electric generator unit, a reciprocating engine generator set, a single combustion turbine used to turn an electric generator, etc.

Fuel Cell: A technology that unites oxygen and hydrogen to generate electricity.

Greenhouse gases: Gases that contribute to global warming. Examples are CO_2, methane, perflurocarbons, and nitrous oxide (N_2O).

IGCC -- Integrated Gasification, Combined Cycle: A technology where coal or other solid fossil fuels are converted to combustible gases. The combustible gases are used as fuel for a combined cycle combustion turbine system to produce electricity.

IQO: An organization recognized by EFSEC to conduct mitigation projects. See RCW 80.70.020 and 050.

Mitigation plan: A plan showing how the owner or operator of a facility will meet the CO_2 mitigation requirements. See RCW 80.70.11 (WAC 173-407-020(11)

Mitigation Projects: Actions or projects to achieve CO_2 mitigation. Examples are energy efficiency measures, clean and efficient transportation measures, managing electricity consumption, sequestering carbon dioxide, cogeneration, reductions in CO_2 or CO_2 equivalents approved in the carbon dioxide mitigation plan, and carbon credits traded or handled by a trading authority or exchange not recognized by EFSEC.

Mitigation quantity: The total amount of CO_2 that needs to be mitigated. The term means the same as Total Carbon Dioxide Emissions (RCW 80.70.17 (WAC 173-407-020(17)).

Notice of Construction (NOC) application: The application required under WAC 173-400-110 or an equivalent requirement of a local air pollution control authority.

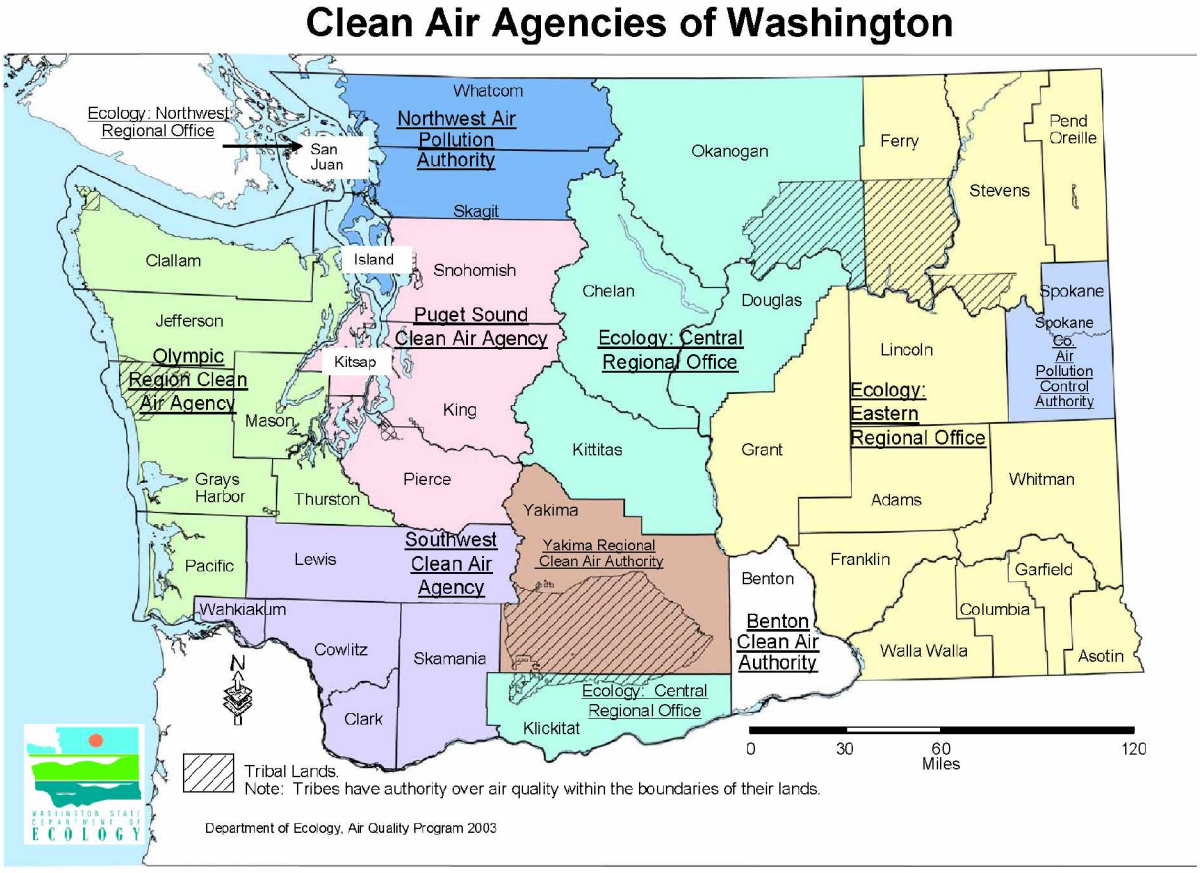
Permanent emission reductions: Emission reductions assured for the lifetime of the project or 30 years, whichever is shorter (RCW 80.70.14 (WAC 173-407-020(14)).

Sequestration of CO_2: A process where CO_2 is bound in a manner preventing it from reentering the atmosphere for the lifetime of the project or longer. Examples are growing trees, and injection of CO_2 into geologic strata or the deep ocean.

Station generating capability: The maximum load a generator can sustain over a given period of time without exceeding design limits. It is calculated from maximum continuous electric generation capacity minus the net auxiliary load. See RCW 80.70.16 (WAC 173-407-020(16)).

Total carbon dioxide emissions: The amount of CO_2 emitted over a 30-year period as a result of the project or project modification. See RCW 80.70.17 (WAC 173-407-020(17).

Appendix 1
Washington State air quality agencies and contact information



Sources of Information about Air Pollution in Washington State			
1.	**Olympic Region Clean Air Agency** *(Clallam, Grays Harbor, Jefferson, Mason, Pacific, Thurston Counties)* 2940 B Limited Lane NW Olympia WA 98502 Richard Stedman, Executive Director Telephone: (360) 586-1044 or 1-800-422-5623 Fax: (360) 491-6308; E-mail: info@oapca.org Internet: http://www.oapca.org	2.	**Department of Ecology – Northwest Regional Office** (*San Juan County)* 3190-160th Avenue SE Bellevue WA 98008-5452 Telephone: (425) 649-7000 Fax: (425) 649-7098, TTY: *1-800-833-6388*
3.	**Northwest Air Pollution Authority** *(Island, Skagit, Whatcom Counties)* 1600 South Second Street Mount Vernon, WA 98273-5202 James Randles, Director Telephone: (360) 428-1617 Telephone: 1-800-622-4627 (Island & Whatcom) Fax: (360) 428-1620; E-mail: info@nwair.org Internet: http://www.nwair.org	4.	**Puget Sound Clean Air Agency** *(King, Kitsap, Pierce, Snohomish Counties)* 110 Union Street, Suite 500 Seattle, WA 98101-2038 Dennis J. McLerran, Air Pollution Control Officer Telephone: (206) 343-8800 or 1-800-552-3565 1-800-595-4341 (Burn Ban Recording) Fax: (206) 343-7522; E-mail: pscleanair.org Internet: http://www.pscleanair.org
5.	**Southwest Clean Air Agency** *(Clark, Cowlitz, Lewis, Skamania, Wahkiakum Counties)* 1308 NE 134th Street Vancouver, WA 98685-2747 Robert D. Elliott, Executive Director Telephone: (360) 574-3058 or 1-800-633-0709 Fax: (360) 576-0925; E-mail: webmaster@swcleanair.org Internet: http://www.swcleanair.org	6.	**Department of Ecology – Central Regional Office** *(Chelan, Douglas, Kittitas, Klickitat, Okanogan Counties)* 15 West Yakima Avenue, Suite #200 Yakima, WA 98902-3401 Telephone: (509) 575-2490 Fax: (509) 575-2809, TTY: *1-800-833-6388*
7.	**Yakima Regional Clean Air Authority** 6 South 2nd Street, Room 1016 Yakima, WA 98901 Les Ornelas, Director Telephone: (509) 574-1410 or 1-800-540-6950 Fax: (509) 574-1411; E-mail: info@yrcaa.org Internet: http://www.co.yakima.wa.us/cleanair	*8.*	***Department of Ecology – Eastern Regional Office*** *(Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Stevens, Walla Walla, Whitman Counties)* *4601 N. Monroe Street,* *Spokane, WA 99205-1295* *Telephone: (509) 329-3502* *Fax: (509) 329-3529, TTY: 1-800-833-6388*
9.	**Spokane County Air Pollution Control Authority** 1101 West College Ave, Suite 403 Spokane, WA 99201 E Director Telephone: (509) 477-4727 Fax: (509) 477-6828; E-mail: publicinfo@scapca.org Internet: http://www.scapca.org	10.	**Benton Clean Air Authority** 114 Columbia Point Dr., Suite C Richland, WA 99352-4387 Dave Lauer, Director Telephone: (509) 943-3396 Fax: (509) 943-0505 or 943-2232; E-mail: email@bcaa.net Telephone: (509) 945-4489 (Burn Ban Recording) Internet: http://www.bcaa.net
	Department of Ecology – Air Quality Program PO Box 47600, Olympia, WA 98504-7600 Telephone: (360) 407-6800 Fax: (360) 407-7534, TTY: *1-800-833-6388* Internet: http://www.ecy.wa.gov/programs/air/airhome.html		**Pulp Mills, Aluminum Smelters** **Department of Ecology – Industrial Section** PO Box 47600, Olympia, WA 98504-7600 Telephone: (360) 407-6916 Fax: (360) 407-6902 TTY: *1-800-833-6388*
	Department of Ecology Southwest Regional Office, PO Box 47775, Olympia, WA 98504-7775 Telephone: (360) 407-6300 – Fax: (360) 407-6305, TTY*: 1-800-833-6388*		

Washington Energy Facility Site Evaluation Council (EFSEC)

Energy Facility Site Evaluation Council
925 Plum Street SE, Building 4
P.O. Box 43172
Olympia, WA 98504-3172
Phone: 360-956-2121
Fax: 360-956-2158

Siting of new projects:
Irina Makarow, Siting Manager
Irinam@cted.wa.gov
(360) 956-2047

Appendix 2
Table of fuel CO_2 conversion factors (from WAC 173-407-050(1)(e)).

Fuel	Kn lb/MMBtu
#2 oil	158.16
#4 oil	160.96
#6 oil	166.67
Lignite	328.57
Sub-bituminous coal	282.94
Bituminous coal, low volatility	312.5
Bituminous coal, medium volatility	274.55
Bituminous coal, high volatility	306.11
Natural gas	117.6
Propane	136.61
Butane	139.38
Petroleum coke	242.91
Coal coke	243.1
Other fossil-fuels	Calculate based on carbon content of the fossil fuel and application of the gross heat content (higher heating value) of the fuel
Nonfossil-fuels	0

Appendix 3
Compliance reviews

Once a facility receives a Notice of Construction approval, Prevention of Significant Deterioration approval, or Air Operating Permit, the reviewing authority will conduct annual or periodic compliance inspections and determinations. Ecology recommends that, for the CO_2 mitigation program, reviewing authorities do annual compliance reviews.

What do reviewing authorities do during compliance reviews?

Depending on the terms of the approved mitigation plan, the reviewing authority will take the following action(s).

- When the applicant is paying an Independent Qualified Organization to do mitigation:
    - Conduct reviews until the applicant has paid the total mitigation cost
    - Confirm the applicant paid the appropriate mitigation fee
- When the applicant is purchasing permanent CO_2 credits:
    - Conduct reviews for 30 years from the date the new unit starts operating commercially or the modified unit restarts after modification.
    - Confirm the facility owner still owns permanent CO_2 credits equal to the quantity of CO_2 emissions required to be mitigated
    - Confirm the credits are the same as in the previous year, unless the permitting authority has given the facility owner permission to sell or trade credits
- For self-mitigation projects:
    - Review the economics to assure the applicant has not used more than 20% of the total funds for mitigation projects or contracts (includes selection, monitoring, and evaluation of mitigation projects and the management and enforcement of contracts)
    - Confirm the progress of the projects
    - Confirm each project is achieving the expected emission reductions
    - Confirm the emission reductions are or will be permanent